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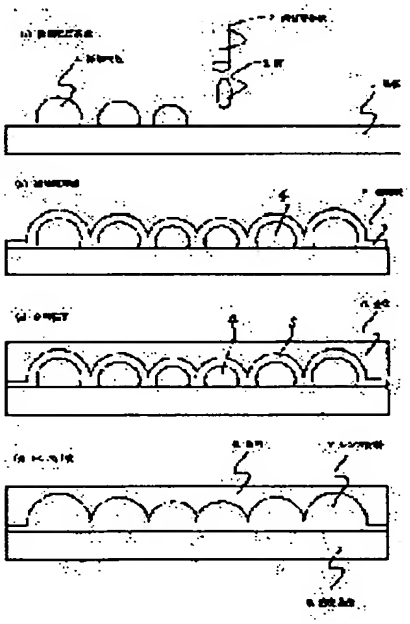
(54) MICROSTRUCTURE AND METHOD FOR MANUFACTURING IT

(57)Abstract:
PROBLEM TO BE SOLVED: To manufacture microstructures such as lenses with flexible embodiments on the same base sheet.
SOLUTION: The microstructure is manufactured by forming microprojections 4 by sticking drops 3 on the base sheet 1 and forming a film 5 at least partly covering the microprojections 4 and the base sheet 1.



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* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The production approach of the micro structure which is the production approach of the micro structure and is characterized by having the process which a drop is made to adhere to (1) substrate and forms a detailed projection, and the process which forms the wrap film for detailed (2) this projection and a substrate partially at least.
[Claim 2] The production approach of the micro structure according to claim 1 characterized by forming two or more detailed projections discretely on a substrate.
[Claim 3] The production approach of the micro structure according to claim 2 characterized by forming two or more detailed projections of all in the same configuration.
[Claim 4] The production approach of the micro structure according to claim 2 characterized by forming two or more detailed projections including a different-species configuration.
[Claim 5] Said film is the production approach of the micro structure given in claim 1 thru/or any of 4 they are. [which is characterized by forming a detailed projection and a substrate as continuation film which covered extensively and continued]
[Claim 6] Said film is the production approach of the micro structure given in claim 1 thru/or any of 4 they are. [which is characterized by forming a detailed projection or a substrate as wrap film alternatively]
[Claim 7] It is the production approach of the micro structure given in claim 1 thru/or any of 6 they are. [which is characterized by whether for the shape of surface type of said substrate to curve, or for it to have the stair-like level difference, and to form a detailed projection in accordance with the shape of surface type to which this substrate curved, and forming on the level difference of the shape of stair-like surface type which this substrate has]
[Claim 8] The production approach of the micro structure given in claim 1 thru/or any of 7 they are. [which is characterized by forming said detailed projection in the shape of the spherical surface]
[Claim 9] The production approach of the micro structure given in claim 1 thru/or any of 7 they are. [which is characterized by forming said detailed projection in the shape of Rhine]
[Claim 10] The production approach of the micro structure given in claim 2 thru/or any of 9 they are. [which is characterized by array-izing said detailed projection regularly or in irregular, and forming it]
[Claim 11] The production approach of the micro structure given in claim 1 thru/or any of 10 they are. [which is characterized by forming according to the process which a drop of the same kind is divided into multiple times by the ink jet method, and it adheres / process / to discharge and a substrate and makes them harden said detailed projection]
[Claim 12] The production approach of the micro structure given in claim 1 thru/or any of 10 they are. [which is characterized by forming according to the process which the drop of two or more classes is divided into multiple times by the ink jet method, and it adheres / process / to discharge and a substrate and makes them harden said detailed projection]
[Claim 13] The production approach of the micro structure given in claim 1 thru/or any of 12 they are. [which is characterized by making said detailed projection transform by heat treatment, and forming it after adhering to discharge and a substrate and making them harden a drop by the ink jet method]
[Claim 14] The production approach of the micro structure given in claim 2 thru/or any of 13 they are. [which is characterized by forming said detailed projection so that radius of curvature may become large at the pitch list of this detailed projection as it goes to this substrate periphery from this substrate center section]
[Claim 15] The production approach of the micro structure given in claim 2 thru/or any of 14 they are. [which is characterized by forming said film until adjoining detailed projections are connected and the flat-surface section during detailed projections is lost]
[Claim 16] The production approach of the micro structure given in claim 1 thru/or any of 15 they are. [which is

characterized by forming said film by electroless deposition]
[Claim 17] The production approach of the micro structure given in claim 1 thru/or any of 15 they are. [which is characterized by forming said film by electroplating]
[Claim 18] The production approach of the micro structure given in claim 1 thru/or any of 15 they are. [which is characterized by forming said film by the chemistry depositing method (CVD)]
[Claim 19] The production approach of the micro structure given in claim 1 thru/or any of 15 they are. [which is characterized by forming said film according to electrodeposition]
[Claim 20] The production approach of the micro structure which is the production approach of the micro structure and is characterized by dividing congener or a drop of a different kind into multiple times by the ink jet method, adhering to discharge and a substrate, stiffening them, and forming a detailed projection on this substrate.
[Claim 21] the micro structure -- a micro structure array -- public funds -- the production approach of the micro structure given in claim 1 thru/or any of 20 they are. [which is characterized by being a mold]
[Claim 22] a micro structure array -- public funds -- a mold -- a micro-lens array -- public funds -- the production approach of the micro structure according to claim 21 characterized by being a mold.
[Claim 23] The micro structure is the production approach of the micro structure given in claim 1 thru/or any of 20 they are. [which is characterized by being a micro-lens array]
[Claim 24] The micro structure characterized by having the film partially formed in the wrap at least in the detailed projection which the drop was made to adhere to a substrate and was formed on this substrate, this detailed projection, and the substrate.
[Claim 25] The micro structure according to claim 24 to which the shape of surface type of said substrate is a curve, or it has the stair-like level difference, and the detailed projection located in a line the shape of an array and in the shape of Rhine on this substrate front face is characterized by being arranged on the level difference of the shape of stair-like surface type which a substrate has in accordance with the shape of surface type to which the substrate curved.
[Claim 26] The micro structure according to claim 24 or 25 characterized by being formed so that radius of curvature may become large at the pitch list of this detailed projection as said detailed projection goes to a substrate periphery from said substrate center section.
[Claim 27] The micro structure according to claim 24, 25, or 26 characterized by said detailed projection having the configuration which carried out eccentricity from the core of this detailed projection.
[Claim 28] The micro structure given in claim 24 thru/or any of 27 they are. [which is characterized by being the continuation film currently formed until the detailed projections which said film adjoins are connected and the flat-surface section during detailed projections is lost]
[Claim 29] The micro structure given in claim 24 thru/or any of 28 they are. [to which said film is characterized by being an electroless deposition layer]
[Claim 30] The micro structure given in claim 24 thru/or any of 28 they are. [to which said film is characterized by being an electrodeposition nature organic compound layer]
[Claim 31] The micro structure given in claim 24 thru/or any of 28 they are. [to which said film is characterized by being an electroplating layer]
[Claim 32] The micro structure given in claim 24 thru/or any of 28 they are. [to which said film is characterized by being the chemistry depositing method (CVD) layer]

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the micro structures, such as metal mold (especially in these specifications, except for the case where it distinguishes, when calling it metal mold, it is used in semantics including metal mold and a metal mold master) for producing the micro-lens array and it which are used in the optoelectronics field etc., the production approach of those, etc.
[0002]
[Description of the Prior Art] A micro-lens array arranges a hundreds of micrometers minute micro lens in the shape of an array from the diameter of about ten micrometers. In the field of optoelectronics, it is used for the purpose, such as a liquid crystal projector and improvement in brightness of a liquid crystal display. It is used for the application as a condenser lens with the application which makes optical connection of a two-dimensional luminescence device array like a surface emission-type laser to others, and a solid state image sensor like CCD. For these applications, there is no free space of light and there is a demand of a micro-lens array with big numerical aperture (NA). Moreover, since a feeling of ZARATSUKI has the advantage that it is few and bright, compared with the conventional thing as a diffusion plate used for the reticle used for focus doubling of a single-lens reflex camera, or a screen, the thing of a micro-lens array mold is used increasingly.
[0003] When using a liquid crystal display panel for a liquid crystal projector, generally optical system like drawing 2 is used. The light by which outgoing radiation was carried out from the light source 9 passes along the optical system 10 called an integrator, and is divided into RGB3 color with a dichroic mirror 11. After passing along a condenser lens 13 and the liquid crystal display panel 14 and carrying out 3 color mixing with the reflective mirror 12 or a half mirror for every color, it is projected by the screen with a projector lens 15. The light of the light source 9 becomes weak as a core is strong and goes to a periphery. Therefore, in reg RETA 10 using the eye-like lens array of a fly divides the area of the liquid crystal display panel 14, and it is made for the whole of each flux of light to be irradiated by the liquid crystal display panel 14. The condenser lens 13 for condensing the illumination light in a projector lens 15 is arranged at the light source side of the liquid crystal display panel 14 united with the micro-lens array in that case.
[0004] The enlarged drawing of a condenser lens 13 and the liquid crystal display panel 14 (it consists of the micro-lens substrate 18, the liquid crystal layer 17, and the TFT (thin film transistor) substrate 16) is shown in drawing 3 R> 3, and the enlarged drawing of the core (a) of the liquid crystal display panel 14 and a periphery (b) is shown in drawing 4 . In the periphery of the liquid crystal display panel 14, the illumination light will carry out incidence aslant for a condenser lens 13. Therefore, the problem to which the use effectiveness of light worsens by the periphery of the liquid crystal display panel 14 occurs.
[0005] As a means to solve this, by JP,2-257119,A and JP,6-180444,A, as shown in drawing 5 , according to the include-angle component of incident light, the configuration by which the incident ray to all micro lenses passes along opening of a liquid crystal display panel is proposed by changing the pitch and radius of curvature of a micro lens 19. Moreover, in JP,5-203941,A, the configuration of the shape of a taper which the distance of the micro lens of only the periphery of a liquid crystal display panel and a liquid crystal layer dwindles linearly toward a periphery from the center section of the liquid crystal display panel is proposed.
[0006] Moreover, in a solid state image sensor, the approach of forming a micro lens on a color filter for condensing is becoming in use. However, since the rate of optical refraction changes with wavelength of various light which carries out incidence to a micro lens, with wavelength, focal distances will differ and the condensing effectiveness to a light sensing portion will fall. Therefore, in JP,6-118209,A and JP,7-176708,A, the method of setting up the configuration or location of each micro lens so that it may be formed on the light sensing portion to which the focus of the incident light condensed by the micro-lens layer corresponds is proposed.
[0007] Moreover, when making optical connection of the field luminescence device arrays by the array pair array,

the configuration which combines a micro-lens array and the diameter lens of macrostomia is fond, and it is used. However, there is a problem that the condensing engine performance deteriorates according to the spherical aberration which the diameter lens of macrostomia has, or the aberration outside a shaft. Therefore, in JP,7-35999,A, by giving a different focal distance and aberration to each micro lens of a micro-lens array, amendment corresponding to the location of each micro lens is performed, and the approach of carrying out image formation by non-aberration mostly is proposed.

[0008] Moreover, a reticle and a diffusion plate are required to have a moderate dotage taste. When a micro lens is arranged periodically, and the direction of the diffracted light was limited in the specific direction, and it faded, and the taste becomes unnatural or it uses together with a Fresnel lens, the problem that cause interference with the zona-orbicularis structure of a Fresnel lens, and a Moire fringe occurs occurs. On the contrary, it is irregular, and when nonuniformity is strong, a blot and the problem of looking darkly partially arise. Therefore, in JP,9-327860,A and JP,11-142609,A, the approach of producing the micro-lens array which broke down periodicity moderately is proposed.

[0009] Thus, in order to make the moderate dotage taste take out to a reticle in order to perform optical amendment for raising the use effectiveness of light, such as a liquid crystal display panel and a solid state image sensor, etc., changing the pitch and radius of curvature within a micro-lens array side is performed, there is no free space of light in these micro-lens arrays, and a thing with big numerical aperture is called for. Moreover, it is easy, and can produce in a short time, and this micro-lens array is asked for it being low cost.

[0010]

[Problem(s) to be Solved by the Invention] By the mechanical processing method, it is very difficult to produce the detailed micro-lens array for these to a precision. Moreover, the micro-lens array with big numerical aperture with the high and use effectiveness of light is unproducible without [of the contact section of a lens] processing.

[0011] As the manufacture approach from the former which is not the mechanical processing method, two or more parts on the substrate which consists of multicomponent glass are formed into a high refractive index, and the approach (M.Oikawa, et al., Jpn.J.Appl.Phys.20(4) L51-54, 1918) of forming two or more lenses directly is learned. However, by this approach, a lens ingredient is limited to glass upwards, and a large-scale manufacturing installation is required for micro-lens array production of a large area, and it will become cost quantity. Moreover, by this manufacture approach, a micro-lens array with big numerical aperture is unproducible.

[0012] There is the reflow method (D.Daly, et al., Proc.MicrolensArrays Teddington., p23-34, 1991) which is made to heat and carry out a reflow of the resin which it left by patterning on a substrate as other approaches of forming a lens directly, and produces a micro-lens array. Since it can create only by patterning, and heating and cooling, it is low cost, and a direct micro lens can be formed on a component and modification of a lens pitch can be easily performed in mask modification. However, since the configuration of a micro lens is dependent on the thickness of resin, and patterning conditions, it is easy to generate dispersion for every lot. Moreover, since the thickness of the resin formed on a substrate is homogeneity mostly, a micro-lens array with big numerical aperture cannot be formed in a micro-lens array side, including two or more radius of curvatures.

[0013] There is the ink jet method (JP,11-142608,A) which resin is made to adhere on a substrate by the ink jet method, and produces a micro-lens array as other approaches of forming a lens directly. The ink jet method generalized as a printing technique can be used for this, it can have the description that a direct micro-lens array can be formed in locations of arbitration, such as a tip of an optical fiber, and can change easily the pitch and radius of curvature within a micro-lens array side. However, when producing the micro-lens array which has a micro lens of millions of pieces from hundreds of thousands of pieces and two or more heads are used, it is difficult to arrange the nozzle of two or more ink jet heads on which the property was ready, and since the amount of resin breathed out for every nozzle is different, in addition to dispersion for every lot, dispersion within a lot will occur. Moreover, when a single nozzle is used, production will take time amount and it will become cost quantity.

[0014] However, if this reflow method and the ink jet method contact a lens, a lens configuration will collapse and numerical aperture will become small. Therefore, it is necessary to arrange so that a lens may not be contacted, and it has the fatal fault that the free space of light cannot be lost. Moreover, there are dispersion for every lot and a fault that production takes time amount.

[0015] Therefore, as an approach of solving these faults, the metal mold of a micro-lens array is produced and the approach of exfoliating and producing the lens ingredient which applied and applied the lens ingredient to metal mold is used. Since this approach can produce a lens easily in a short time once the repeatability for every lot is good and produces metal mold, in order to produce a lens with shaping, it is the optimal approach for producing the micro lens of low cost. Generally produced metal mold is considered as a metal mold master (original edition), and he imprints to metal mold, and is trying for the durable time amount of the metal mold

master produced once to go up by using it as metal mold.
[0016] There is the approach (JP,1-231601,A) of drawing using an electron beam as a manufacturing method of a metal mold master. If this approach is used, it is possible for there to be no free space of light, and to be able to produce a micro-lens array with a big numerical aperture, and to change the pitch and radius of curvature within a micro-lens array side into arbitration. However, an electron beam exposure system is very expensive, there is a trouble that a drawing-surface product is narrow and production of the metal mold of a large area is not easy, and it is hard to call it the easy production approach by low cost.
[0017] Moreover, there is the approach (JP,5-303009,A) of etching and forming some metal plates as a manufacturing method of other metal mold masters. There is an etching dependency to a metal plate, etching will advance by rinsing after etching, and this approach will shift from desired lens radius of curvature. Moreover, when etching until the free space of light is lost, if the pitch and radius of curvature of a lens which adjoined differ from each other, the difference in the etching time between lenses will occur, and it will shift from desired lens radius of curvature.
[0018] As mentioned above, by the approach of manufacturing a lens directly, it has the problem that a micro-lens [with the high and use effectiveness of light] array with large numerical aperture is unproducible. In order to produce one lens at a time moreover, the repeatability for every lot is not good, or has the problem referred to as taking time amount in production. If the approach of using a metal mold master is used, a lot of [cheaply] micro-lens arrays can be produced, and this problem can be solved. However, the approach of producing this metal mold master is cost quantity, and it has the trouble that it is difficult to produce a desired configuration when two or more pitches and radius of curvatures exist, in the problem that cannot respond to a large area but productivity is low, and a micro-lens array side. Therefore, the manufacture approach of the cheap micro-lens array metal mold master which can produce easily the lens which has the pitch from which two or more classes for the purpose which performs optical amendment differ, and radius of curvature in the same substrate of a micro-lens array metal mold master is needed. In addition, if this microphone ROREN array metal mold master does not imprint metal mold but a direct lens is fabricated, it can be used as micro-lens array metal mold, and if the metal mold master itself has permeability in an operating wavelength region, it can also be used as a micro-lens array etc.
[0019] This invention is accomplished in view of the technical problem which the above-mentioned conventional technique has. The purpose (1) The micro structures, such as a lens of the configuration where plurality differed, can also be formed on the same substrate. (2) arranging the micro structures, such as a lens, in the location of the arbitration of a substrate [easy] (3) — a free space — easy — it can lose — (4) — it is in offering the micro structures, such as a comparatively cheap micro-lens array and micro-lens array metal mold, and the production approach of those.
[0020]
[Means for Solving the Problem] The production approach of the micro structure of this invention which attains this purpose is characterized by having the process which a drop is made to adhere to (1) substrate and forms a detailed projection, and the process which forms the wrap film for detailed (2) this projection and a substrate partially at least. According to such an approach, the micro structures, such as a lens, can be created on the same substrate in a flexible mode.
[0021] Based on this basic configuration, a more concrete gestalt [like / a less or equal] is possible. Typically, two or more formation of the detailed projection is discretely carried out on a substrate. Two or more detailed projections of all are formed in the same configuration, or are formed including a different-species configuration. What is necessary is just to decide this according to an application.
[0022] Typically, said film is formed as continuation film which covered the detailed projection and the substrate extensively and continued. However, said film may be alternatively formed as wrap film in a detailed projection or a substrate.
[0023] Said substrate can take the gestalt which the shape of the surface type is curving, or has the stair-like level difference, and a detailed projection may be formed on the level difference of the shape of stair-like surface type which forms in accordance with the shape of surface type to which this substrate curved, or this substrate has.
[0024] Said detailed projection is formed in the shape of the spherical surface, or is formed in the shape of Rhine. This configuration can take various gestalten and this should just also determine it according to an application. Moreover, said detailed projection is array-ized regularly or in irregular.
[0025] A drop of the same kind is divided into multiple times by the ink jet method, it adheres to discharge and a substrate and they are stiffened, it is formed or said detailed projection can also be formed by dividing the drop of two or more classes into multiple times by the ink jet method, adhering to discharge and a substrate and stiffening them. adhesion of each drop and the method of hardening can come out variously according to the

class of the ingredient. For example, after adhering to discharge and a substrate and making them harden a drop by the ink jet method, said detailed projection can be made to be able to deform by heat treatment, and can also be formed.

[0026] Said detailed projection can also be formed so that radius of curvature may become large at the pitch list of this detailed projection, as it goes to this substrate periphery from this substrate center section. What is necessary is just to set this up according to an application.

[0027] Said film can also be formed until adjoining detailed projections are connected and the flat-surface section during detailed projections is lost.

[0028] Said film may be formed of electroless deposition, electroplating, the chemistry depositing method (CVD), electrodeposition, etc. What is necessary is just to also decide this according to an application.

[0029] Moreover, the production approach of the micro structure of this invention which attains the above-mentioned purpose is characterized by dividing congener or a drop of a different kind into multiple times by the ink jet method, adhering to discharge and a substrate, stiffening them, and forming a detailed projection on this substrate. Also by such approach, the micro structures, such as a lens, can be created on the same substrate in a flexible mode.

[0030] the above-mentioned micro structure — typical — a micro-lens array — public funds — micro structure arrays, such as a mold, — public funds — a mold and a micro-lens array — public funds — it is a mold.

[0031] Furthermore, the micro structure of this invention which attains the above-mentioned purpose is characterized by having the film partially formed in the wrap at least in the detailed projection which the drop was made to adhere to a substrate and was formed on this substrate, this detailed projection, and the substrate. Also with this configuration, the micro structure can take a flexible gestalt, as stated in the top.

[0032]

[Embodiment of the Invention] The above is the fundamental component and the more concrete mode of the micro structure of this invention, and its production approach, and uses and explains drawing 1 below using a typical example about the detail and operation.

[0033] The substrate 1 which forms a micro-lens array metal mold master (original edition) in drawing 1 (a) is shown. As a substrate ingredient, it is also possible to use which ingredient of a metal, a semi-conductor, and an insulator. A metal membrane may be formed on this substrate 1. A substrate 1 needs to perform surface treatment, such as a water-repellent finish, and needs to control it to desired surface tension and boundary tension. A certain pattern may perform this surface treatment alternatively. Since a layer will be formed besides forming faces, such as a micro lens, when using an electroplating layer and the electrodeposted organic substance for the continuation film mentioned later, as for a substrate, it is desirable to use an insulator. Moreover, as for a substrate 1, being washed enough is desirable in order to raise adhesion with the detailed projection formed in a front face.

[0034] First, as shown in drawing 1 (b), on the field of a substrate 1, a drop 3 is made to adhere using the suitable drop adhesion means 2, and the detailed projection 4 is formed. The ink jet method can be used as a drop adhesion means 2. This is the printing technique generally used by the printer etc., and things, such as a mask and a mold, are unnecessary and it can create a pattern with the detailed configuration of arbitration at a high speed. A hot melt type besides the piezo type using the piezoelectric device as a method of an ink jet and the bubble jet (trademark) type using the electric thermal-conversion object as an energy generation component etc. is usable.

[0035] It is made to breathe out a drop with minute number pl extent by the ink jet method. Since the Reynolds number will also decrease if the dimension of a drop becomes small, it can be called an approach ideal for the location of a drop, and maintenance of a configuration. The ink jet method is explained using drawing 6 . It is made to adhere a drop to arrangement of arbitration-dimensional [2] or by carrying out three-dimensions migration with driving gears 21 and 26 in the stage 25 holding the ink jet head 20 or a substrate 19. The magnitude of a detailed projection is controllable free changing the strength of the regurgitation, and by using the nozzle (delivery) of two or more magnitude.

[0036] Moreover, the head which the nozzle was made to correspond to a micro-lens array etc., and has arranged it two-dimensional may be used. However, the property of a nozzle simple substance is different a little, respectively, and dispersion in discharge quantity and the difference in an impact location come out. Therefore, as long as it seems that it becomes a precision top problem, using a single nozzle, beforehand, the property of a nozzle may be measured and you may perform enabling it to control to the optimized discharge quantity.

[0037] The regurgitation may be repeated in the same location or the location shifted a little. Even if the distance from a nozzle to a substrate changes, since the configuration or location at the time of impact do not change, they only scan a head or a stage to two dimensions, and can respond to a substrate with the curved

substrate or the curved stair-like level difference etc. Moreover, a drop 3 may be made to adhere continuously or intermittently, although the direction which carries out the regurgitation to head 20 list at the time of quiescence of a stage 25 is stabilized by the configuration of the drop which reached the target, and the location, moving a head or a stage. By it, the drop from which the configuration shifted can also be formed in a certain direction. While a monitor 24 performs the configuration of a drop and the monitoring of an impact location which reached the target using a sensor, CCD23, etc. in any case, it is desirable to perform the regurgitation of a drop.

[0038] It is necessary to be what is suitable for the regurgitation, adheres as an ingredient of a drop 3, and can be hardened in a stable configuration, and it is possible to use heat hardening mold resin, energy hardening mold resin, etc. For example, they are acrylic resin, allyl compound system resin, methacrylic system resin, etc. These resin can be used in the state of [every] a monomer, oligomer, and a polymer. A drop is stabilized, and it needs to adjust viscosity so that the regurgitation may be carried out.

[0039] It is necessary to adjust surface tension and boundary tension so that a drop may take a desired configuration on a substrate. By giving a water-repellent finish at a substrate, the contact angle between a substrate and a drop can be enlarged and a contact angle can be enlarged also by making viscosity of a drop into hyperviscosity. It is desirable to adjust the component of an ingredient using an additive etc. so that the viscosity of a drop 3, the surface tension on a substrate, and boundary tension may become the optimal.

[0040] Resin etc. may be dropped using a dispenser as other drop adhesion means 2. However, since formation of severalmicro about I drop generally serves as a minimum, it is suitable when the diameter of a lens produces a comparatively big lens etc. When a dispenser is used, there is an advantage that the regurgitation of the resin with comparatively high viscosity can be carried out. Moreover, the glass or the metal in which it was made to dissolve may be made dropped, and you may form. In this case, the need of being cautious of deformation and fusion of a substrate 1 comes out.

[0041] The detailed projection 4 is formed according to an array with each lens in a micro-lens array etc. This detailed projection 4 may deform in what is formed in an ellipsoid configuration, and a certain direction. The detailed projection 4 with a different configuration or magnitude may be included periodically. Moreover, this detailed projection 4 may be formed in the shape of Rhine. A lenticular lens etc. can be formed by this.

[0042] Moreover, magnitude and a location have irregularity and this detailed projection 4 may be arranged. By this, the reticle used for 1 eye REFUKAMERA can be formed. Moreover, the structure for ally MENTOMA-KU for the alignment of a micro-lens array etc. and other modules can also be formed by controlling the configuration of the detailed projection 4, and a location.

[0043] Next, in order to stabilize a configuration, it is necessary to stiffen the detailed projection 4. Before stiffening the detailed projection 4, a configuration may be prepared by performing a reflow. If it cools so that temperature distribution may arise after a reflow and in a drop, the micro structure with an aspheric surface configuration will be obtained. To reheat the case where the heated drop is formed in a substrate side, and a drop and prepare a configuration, the melting point of drop 3 ingredient is compared with the melting point of a substrate 1, and it is necessary to choose a substrate and a drop ingredient so that there may not be deformation and fusion of a substrate.

[0044] The detailed projection 4 can form the micro structure of various configurations by dividing into multiple times and forming in piles. In that case, after making a drop adhere once and making it harden, whether the drop's being adjoined anew and actuation of making the drop from which a class differs in the location with which it laps adhere may be repeated. Under the present circumstances, it is made to become higher than the melting point of the resin which carried out discharge hardening of the melting point of the resin made [the eye] to carry out discharge hardening once the second time, a reflow may be performed, and a configuration may be prepared. Under the present circumstances, the lens in which the core of a lens carried out eccentricity can be obtained.

[0045] Furthermore, as shown in drawing 1 (b), the continuation film 5 is formed on a substrate 1 at detailed projection 4 list. As continuation film 5, any, such as an electroplating layer, an electroless deposition layer, an electrodeposition nature organic layer, a chemistry deposit (CVD layer), and vacuum evaporationo film, are sufficient. Since isotropic layer growth is made, the configuration of the detailed projection 4 is maintained and electroless deposition and the chemistry depositing method can obtain the desired micro structure. In the case of an electroplating layer or an electrodeposition nature organic layer, it is necessary to form an electrode layer on detailed projection 4 front face and a substrate 1 as pretreatment of continuation film 5 formation. In the case of an electroless deposition layer, it is appropriate for this pretreatment to consider as the process which performs activity by the catalyst.

[0046] Moreover, a metal membrane is formed on a substrate 1 in a detailed projection 4 front-face top list with a vacuum deposition sputtering system, and it can also substitute performing electroless deposition for

electroplating after short-time ******. As a metal of the main plating, with a single metal, there are nickel, Au, Pt, Cr, Cu, Ag, Zn, etc., and there are Cu-Zn, Sn-Co, nickel-Fe, Zn-nickel, etc. with an alloy. However, it is possible to use anythings, if it is the ingredient which can be plated.

[0047] What is necessary is just to grow up the continuation film 5 until the spherical surfaces contact. Furthermore, the micro-lens array whose use effectiveness of light is about 100% can be obtained by growing up this continuation film 5 until the flat-surface section between the spherical surfaces is lost. By controlling the thickness of this continuation film 5, the configuration and curvature of a lens etc. are controllable free.

[0048] Moreover, when the continuation film 5 is an electroless deposition layer, by performing actuation of ********-izing only a detailed projection front face alternatively, it cannot be influenced [of electroless deposition growth] from a substrate 1, but the micro structure which maintained the configuration of the detailed projection 4 faithfully more can be obtained. In this case, electroless deposition can be made to start with some means, like the metal with which the resin itself which carries out the regurgitation is used for activation of electroless deposition is included.

[0049] Moreover, when continuation film is an electroless deposition layer, an electroplating layer, and an electrodeposted organic layer, the micro structure of the aspheric surface which collapsed from the configuration of the detailed projection 4 can be obtained by limiting pretreatment only to the substrate section in which the detailed projection is not formed, and performing it. With the insulator substrate which forms the metal membrane, even if it forms the continuation layer 5 by the electroplating layer or the electrodeposted organic layer, the same effectiveness is acquired.

[0050] the micro-lens array produced by the above-mentioned approach — public funds — if the substrate 1 which constitutes a mold master, the detailed projection 4, and the continuation film 5 have permeability in an operating wavelength region, it is also possible to use the metal mold master itself as a micro-lens array, a reticle, etc.

[0051] Furthermore, as shown in drawing 1 (c), after forming a metal mold ingredient in the metal mold masters for [which was produced by the above-mentioned approach] micro-lens arrays (original edition), the metal mold for micro-lens arrays etc. is obtained by exfoliating metal mold 6. Since direct formation can be carried out from a metal mold master, micro-lens metal mold etc. does not need an expensive facility, but can produce it by low cost. What is necessary is just to exfoliate a metal mold master and metal mold mechanically as the approach of exfoliation.

[0052] However, when it may deform at the time of exfoliation for oban-izing and the continuation film 5 may separate with the continuation film 5 and substrate 1 of a metallurgy mold master, or the not sufficient adhesion of the detailed projection 4, the approach of etching a substrate, a resin layer, and the continuation film from a rear face one by one may be taken. When forming metal mold after preparing a sacrifice layer on the continuation film 5, it is possible by removing a sacrifice layer to exfoliate a metal mold master and metal mold. In this case, an ingredient of a sacrifice layer with which metal mold is not corroded by the etchant which etches a sacrifice layer is chosen. When a metal mold master is not corroded by the etchant which etches a sacrifice layer, it is possible to carry out multiple-times use, using a metal mold master as the original edition. Multiple times until it becomes impossible to use a metal mold master with a blemish, dirt, etc. are usable.

[0053] If it can form by a certain approach on the continuation film 5 of a golden form master and can exfoliate as an ingredient of the metal mold for micro lenses, any ingredients, such as resin, a metal, and an insulator, will be used. After applying melting or the dissolved solution of a resin metallurgy group and glass on the substrate 1 with which the continuation film 5 was formed and stiffening it as the formation approach of the simple metal mold 6, it exfoliates by the above-mentioned exfoliation approach, and forms. As other approaches, a metal membrane is formed on a metal mold master, it uses as cathode, and there is a method of performing electroplating and ******(ing) metal mold one by one. If a sacrifice layer is used, the electrode layer for metal mold will be formed on a sacrifice layer, and electroplating will be performed by using this electrode layer for metal mold as cathode.

[0054] Furthermore, as shown in drawing 1 (d), after forming the ingredient 7 used as a micro lens etc. on the metal mold 6 for micro-lens arrays etc., a micro-lens array etc. can be formed by exfoliating this. It becomes possible to be low cost and to produce the micro-lens array of the same configuration etc. in large quantities easily by this. The ingredient in which light transmission is possible is used for a micro-lens array ingredient in the wavelength field of the light which light-receiving which uses a micro lens, or luminescence equipment uses.

[0055] In consideration of the process of exfoliation, an ingredient with easy detachability with metal mold needs to form a mold release layer between metal mold, a micro-lens array, etc. as ingredients, such as a micro-lens array, using an easy thing. After applying the heat-curing resin of light transmission nature, ultraviolet-rays hardening resin, electron ray hardening resin, etc. on the metal mold for micro-lens arrays etc., it is made to harden by heating, UV irradiation, electron beam irradiation, etc., when using resin as ingredients, such as a

micro-lens array. In this case, it is desirable to perform degassing at the time of hardening, so that air bubbles may not be formed.

[0056] If the fused glass is used as ingredients, such as a micro-lens array, the micro lens of glass etc. is producible. Moreover, when the endurance of the metal mold masters for micro-lens arrays etc. is satisfactory, resin, such as a direct lens ingredient, may be applied on a metal mold master, a micro-lens array etc. may be produced, and the metal mold masters for micro-lens arrays etc. may be used as metal mold for micro-lens arrays etc.

[0057] Hereafter, the example of this invention is explained to a detail along with a drawing.

[0058] (The 1st example) In the 1st example, the silicon wafer (110) substrate with a thickness of 525 micrometers by which both sides are processed on the mirror plane by the optical grinding method of 4 inch phi is used. Alkali cleaning and UV ozonization are performed in order to raise the adhesion reinforcement of the drop and substrate which are made to adhere. Furthermore, a water-repellent side is formed in a substrate front face using a silane coupling agent with the functional group which has a fluorine.

[0059] Piezo type ink jet equipment is used for a part to form the lens on a substrate in, and acrylic ultraviolet-rays hardening resin is made to adhere to it in the shape of an array. The amount of the resin which carries out the regurgitation is changed using the same ink jet head, and the detailed projection to which magnitude and a pitch become large regularly is formed as it goes to a periphery from a substrate core. A detailed projection is formed in the shape of [640x480] an array in a 26mmx19.5mm field. The drop became convex lens-like with surface tension, and the contact angle was about 90 degrees. Ultraviolet rays are irradiated, and are stiffened, with the configuration of a drop maintained, and a detailed projection is formed (refer to drawing 1 R> 1 (a)).

[0060] Next, after soaking a substrate in a conditioner solution, it dips in the catalyst solution containing the colloid of palladium-tin, and a catalyst nucleus is formed in a detailed projection and a substrate front face. The continuation film of electroless deposition is made to form until the flat part between the adjoining spherical surfaces is lost using 90-degree C electroless-nickel-plating liquid. the micro-lens array which the electroless deposition layer is formed isotropic on the detailed projection and the substrate, and reflected the configuration of a detailed projection — public funds — the mold master 41 was producible (refer to drawing 1 (b)). The top view of this is shown in drawing 7 .

[0061] Then, on an electroless deposition layer, the release agent for electrocasting is applied and a mold release layer is formed. An electroformed mold is produced by electroplating using the plating bath which uses this substrate as cathode and uses nickel amiosulfonate as a principal component (refer to drawing 1 (c)). the micro-lens array which exfoliated — public funds — the glass which serves as a support substrate after spreading with a dispenser in ultraviolet-rays hardening resin is put on a mold, and ultraviolet rays are irradiated and are stiffened (refer to drawing 1 (d)). By exfoliating glass mechanically from this metal mold, the convex type micro-lens array from which the magnitude and the pitch of a lens changed regularly was obtained as it went to the periphery from the substrate core. This has the same configuration as the metal mold master 41 shown in drawing 7 . This micro-lens array does not have the unused field of light in order not to have the flat-surface section between the adjoining lens spherical surfaces.

[0062] Moreover, the liquid crystal display panel of 1.3 inch VGA is equipped with this micro-lens array, and the light source, an integrator, and a condenser lens are arranged (refer to drawing 2). When the brightness of the light which penetrates a liquid crystal panel was measured, compared with the time of micro-lens array wearing with uniform magnitude and pitch of a lens, it has checked that the quantity of light was homogeneity within a liquid crystal display panel.

[0063] (The 2nd example) In the 2nd example, the silicon wafer (110) substrate with a thickness of 525 micrometers by which both sides are processed on the mirror plane by the optical grinding method of 4 inch phi is used. Alkali cleaning and UV ozonization are performed in order to raise the adhesion reinforcement of the drop and substrate which are made to adhere. Furthermore, a water-repellent side is formed in a substrate front face using a silane coupling agent with the functional group which has a fluorine.

[0064] Next, piezo type ink jet equipment is used for a part to form the lens on a substrate in, and acrylic ultraviolet-rays hardening resin is made to adhere to it in the shape of Rhine. The detailed projection of the shape of Rhine to which magnitude and a pitch become large regularly is formed as a head is made to scan and it goes to a periphery from a substrate core using the same ink jet head, making resin continuous. A detailed projection is formed in the lengthwise direction in a 26mmx19.5mm field in the shape of [480] Rhine. A drop becomes strip of paper-like with surface tension, and a contact angle is about 90 degrees. Ultraviolet rays are irradiated, and are stiffened, with the configuration of a drop maintained, and a detailed projection is formed.

[0065] Then, after soaking a substrate in a conditioner solution, it dips in the catalyst solution containing the colloid of palladium-tin, and a catalyst nucleus is formed in a detailed projection and a substrate front face. The continuation film of electroless deposition is made to form until the flat part between the adjoining spherical

surfaces is lost using 90-degree C electroless-nickel-plating liquid. The electroless deposition layer is formed isotropic on the detailed projection and the substrate, and has produced the metal mold master 42 for lenticular lenses reflecting the configuration of a detailed projection. The perspective view of this is shown in drawing 8 .

[0066] Like the above, the detailed projection was formed in the longitudinal direction in a 26mmx19.5mm field in the shape of [640] Rhine, and two kinds of metal mold masters for lenticular lenses were obtained.

[0067] Here, by the same approach as the 1st example, two kinds of electroformed molds are produced and the lenticular lens which carried out even replica shaping is produced, respectively. The liquid crystal display panel of 1.3 inch VGA is equipped with two sheets in piles, and the light source, an integrator, and a condenser lens are arranged. When the brightness of the light which penetrates a liquid crystal panel was measured, compared with the time of micro-lens array wearing uniform [the magnitude and the pitch of a lens], and single, it has checked that the quantity of light was homogeneity within a liquid crystal display panel.

[0068] (The 3rd example) In the 3rd example shown in drawing 9 , the quartz substrate 30 of a 4 inch angle with a thickness of 10mm by which both sides are processed on the mirror plane by the optical grinding method is used. By wet etching, the curve of the shape of a taper dwindled linearly is prepared in the substrate 30 as it goes to a periphery from the core of a substrate. Moreover, alkali cleaning and UV ozonization are performed in order to raise the adhesion reinforcement of the drop and substrate 30 which are made to adhere. Furthermore, a water-repellent side is formed in a substrate front face using a silane coupling agent with the functional group which has a fluorine.

[0069] Next, acrylic ultraviolet curing mold resin 31 is made to adhere in accordance with the taper configuration of the curved substrate 30 in the pitch of about 40.6 micrometers using piezo type ink jet equipment in the shape of [640x480] an array in fixed discharge quantity. The drop became convex lens-like with surface tension, the contact angle was about 90 degrees and the diameter was about 35 micrometers. With the configuration of a drop maintained, 120 degrees C of substrates 30 are dried for 15 minutes on a hot plate, and the detailed projection which hardened is formed.

[0070] Then, after soaking this substrate in a conditioner solution, it dips in the catalyst solution containing the colloid of palladium-tin, and a catalyst nucleus is formed in a detailed projection and a substrate front face. And the continuation film 32 of electroless deposition is made to form until the flat part between the adjoining spherical surfaces is lost using 90-degree C electroless-nickel-plating liquid. The electroless deposition layer 32 is formed isotropic on the detailed projection 31 and the substrate 30. in this way, the micro-lens array which met the substrate configuration which curved almost reflecting the configuration of the detailed projection 31 as shown in the sectional view of drawing 9 — public funds — the mold master was obtained.

[0071] By the same approach as the 1st example, an electroformed mold is produced, the liquid crystal display panel of 1.3 inch VGA is equipped with the micro-lens array which carried out even replica shaping, and the light source, an integrator, and a condenser lens are arranged. When the brightness of the light which penetrates a liquid crystal panel was measured, compared with the time of micro-lens array wearing to which the substrate is not curving, it has checked that the quantity of light was homogeneity within a liquid crystal display panel.

[0072] (The 4th example) Process drawing of the method of producing the micro-lens array metal mold master in the 4th example is shown in drawing 10 . The quartz substrate 33 of a 4 inch angle with a thickness of 5mm by which both sides are processed on the mirror plane by the optical grinding method is used. Alkali cleaning and UV ozonization are performed in order to raise the adhesion reinforcement of the drop and substrate which are made to adhere to a substrate 33. Furthermore, a water-repellent side is formed in a substrate front face using a silane coupling agent with the functional group which has a fluorine.

[0073] First, acrylic ultraviolet-rays hardening resin 34 is made to adhere in the pitch of about 62.5 micrometers in the shape of [800x600] an array in fixed discharge quantity using piezo type ink jet equipment. Since this resin 34 used what has the high melting point by hypoviscosity at the time of a polymer, the drop became the shape of a convex lens with a little even top-most vertices, and the diameter was about 57 micrometers. Ultraviolet rays are irradiated, and are stiffened, with the configuration of a drop maintained, and the 1st detailed projection 34 is formed.

[0074] Next, on the 1st detailed projection 34, the acrylic ultraviolet-rays hardening resin 35 of a class with the more low melting point is made to adhere to the location which carried out eccentricity from the core of the detailed projection 34, it irradiates at the time of a polymer, ultraviolet rays are stiffened at it, and the 2nd detailed projection 35 is formed. Here, only the 2nd detailed projection 35 is dissolved with heating, and the 3rd detailed projection 36 which carried out eccentricity from the core of a detailed projection is formed.

[0075] Then, after soaking a substrate in a conditioner solution, it dips in the catalyst solution containing the colloid of palladium-tin, and a catalyst nucleus is formed in the detailed projection 36 and substrate 33 front face. And the continuation film 37 of electroless deposition is made to form until the flat part between the adjoining spherical surfaces is lost using 90-degree C electroless-nickel-plating liquid. The electroless deposition

layer 37 is formed isotropic on the detailed projection 36 and the substrate 33, and has produced the micro structure array which reflected the configuration of the detailed projection 36 mostly. the micro-lens array which met the substrate configuration by this — public funds — the mold master was obtained.
[0076] The micro-lens array which carried out eccentricity from the lens core was able to be obtained by producing an electroformed mold and performing replica shaping by the same approach as the 1st example. It has checked that the micro-lens array which has by this the astigmatism which is carrying out eccentricity from the lens core for every lens was producible.
[0077] (The 5th example) In the 5th example, the silicon wafer (110) substrate with a thickness of 525 micrometers by which both sides are processed on the mirror plane by the optical grinding method of 4 inch phi is used. Alkali cleaning and UV ozonization are performed in order to raise the adhesion reinforcement of the drop and substrate which are made to adhere. Furthermore, a water-repellent side is formed in a substrate front face using a silane coupling agent with the functional group which has a fluorine.
[0078] Next, piezo type ink jet equipment is used for a part to form the lens on a substrate in, and acrylic ultraviolet-rays hardening resin is made to adhere to it in the shape of an array. The amount of the resin which carries out the regurgitation is changed using the same ink jet head, and the detailed projection to which magnitude and a pitch become large regularly is formed as it goes to a periphery from a substrate core. A detailed projection is formed in the shape of [640x480] an array in a 26mmx19.5mm field. The drop became convex lens-like with surface tension, and the contact angle was about 90 degrees. Ultraviolet rays are irradiated, and are stiffened, with the configuration of a drop maintained, and a detailed projection is formed (refer to drawing 1 (a)).
[0079] Then, after soaking a substrate in a conditioner solution, it dips in the catalyst solution containing the colloid of palladium-tin, and a catalyst nucleus is formed in a detailed projection and a substrate front face. And the continuation film of electroless deposition is made to form until the flat part between the adjoining spherical surfaces is lost using 90-degree C electroless-nickel-plating liquid. the micro-lens array which the electroless deposition layer is formed isotropic on the detailed projection and the substrate, and reflected the configuration of a detailed projection — public funds — the mold was producible (refer to drawing 1 (b)).
[0080] The glass which serves as a support substrate after spreading with a dispenser in ultraviolet-rays hardening resin is put on this metal mold for micro-lens arrays, and ultraviolet rays are irradiated and are stiffened. The concave micro-lens array was obtained by exfoliating glass mechanically from a substrate. Furthermore, after spreading and glass are put for the ultraviolet-rays hardening resin with which previously differs from a refractive index on this concave micro-lens array with a dispenser, and ultraviolet rays are irradiated and are stiffened. Thereby, the monotonous micro-lens array in which the magnitude and the pitch of a lens contain the micro-lens array which changed regularly was obtained as it went to the periphery from the substrate core (refer to drawing 1). This monotonous micro-lens array did not have the unused field of light in order not to have the flat-surface section between the adjoining lens spherical surfaces.
[0081] Moreover, the liquid crystal display panel of 1.3 inch VGA is equipped with this micro-lens array, and the light source, an integrator, and a condenser lens are arranged. When the brightness of the light which penetrates a liquid crystal panel was measured, compared with the time of micro-lens array wearing with uniform magnitude and pitch of a lens, it has checked that the quantity of light was homogeneity within a liquid crystal display panel.

[0082] (The 6th example) In the 6th example, the quartz substrate of a 4 inch angle with a thickness of 5mm by which both sides are processed on the mirror plane by the optical grinding method is used. On a substrate, 1000A (Indium Tin Oxide) of ITO(s) which are a transparent electrode is formed by the vacuum spatter. Alkali cleaning and UV ozonization are performed in order to raise the adhesion reinforcement of the drop and substrate which are made to adhere. Furthermore, a water-repellent side is formed in a substrate front face using a silane coupling agent with the functional group which has a fluorine.
[0083] Next, piezo type ink jet equipment is used for a part to form the lens on a substrate in, and acrylic ultraviolet-rays hardening resin is made to adhere to it in the shape of an array. The amount of the resin which carries out the regurgitation is changed using the same ink jet head, and the detailed projection to which magnitude and a pitch become large regularly is formed as it goes to a periphery from a substrate core. A detailed projection is formed in the shape of [640x480] an array in a 26mmx19.5mm field. The drop became convex lens-like with surface tension, and the contact angle was about 90 degrees. Ultraviolet rays are irradiated, are stiffened, with the configuration of a drop maintained, and a transparent detailed projection is formed.
[0084] Then, using the anion mold electrodeposition bath containing a 25-degree C acrylic compound, the transparent electrode ITO on a substrate is made into an anode plate, and it is electrodeposited by current density 50 mA/dm2, and the continuation film of an electrodeposition nature organic compound is made to form

until it covers all detailed projections and the flat part between the adjoining spherical surfaces is lost. This consisted of acrylic resin which is transparence resin, and the convex type micro-lens array from which the magnitude and the pitch of a lens changed regularly was obtained as it went to the periphery from the substrate core. This micro-lens array did not have the unused field of light in order not to have the flat-surface section between the adjoining lens spherical surfaces.

[0085] Moreover, the liquid crystal display panel of 1.3 inch VGA is equipped with this micro-lens array, and the light source, an integrator, and a condenser lens are arranged. When the brightness of the light which penetrates a liquid crystal panel was measured, compared with the time of micro-lens array wearing with uniform magnitude and pitch of a lens, it has checked that the quantity of light was homogeneity within a liquid crystal display panel.

[0086]

[Effect of the Invention] As explained above, the pitch and radius of curvature of a lens etc. could be freely controlled by the production approach of this invention on the same substrate, and it enabled it to produce cheaply the micro-lens array which whose use effectiveness of light is about 100%, and can also enlarge numerical aperture, micro-lens array metal mold, etc.

[0087] Moreover, it became possible by changing the surface state of the substrate at the time of drop adhesion, the viscosity of a drop, regurgitation conditions, etc. to form the lens which carried out the configuration of arbitration in the same substrate. Furthermore, since production of a mask etc. was not needed, when arrangement of a lens etc. was changeable free with high precision, it could respond to modification of a design etc. flexibly by low cost. Since it was used when it was the substrate to which a drop can be made to adhere, it also became possible to correspond in the shape of [various] surface type. Furthermore, it also became possible by optimizing the thickness of the continuation film to lose the free space of light etc.

[0088] Since replica shaping of the micro-lens array etc. was able to be imprinted and carried out and it acquired a master configuration to metal mold, it became possible [producing a cheap micro-lens array etc. with sufficient repeatability in large quantities by low cost]. Moreover, since the degree of freedom of arrangement of the micro structures, such as a lens, increased sharply, formation of an alignment marker with a liquid crystal display panel etc. also became easy.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is drawing showing the process of the micro-lens producing method in the micro-lens array metal mold master list of this invention.
[Drawing 2] Drawing 2 is drawing showing the optical system of a general liquid crystal projector.
[Drawing 3] Drawing 3 is the enlarged drawing of a condenser lens and a liquid crystal display panel.
[Drawing 4] Drawing 4 is the enlarged drawing of the core of a liquid crystal display panel, and a periphery.
[Drawing 5] Drawing 5 is drawing showing the configuration of a micro lens by which the conventional proposal is made.
[Drawing 6] Drawing 6 is the system chart showing the detailed projection formation equipment used for this invention.
[Drawing 7] Drawing 7 is the mimetic diagram showing the micro-lens array metal mold master in the 1st example of this invention.
[Drawing 8] Drawing 8 is the perspective view showing the lenticular lens metal mold master in the 2nd example of this invention.
[Drawing 9] Drawing 9 is the sectional view showing the micro-lens array metal mold master in the 3rd example of this invention.
[Drawing 10] Drawing 10 is drawing showing the process of the method of producing the micro-lens array metal mold master in the 4th example of this invention.
[Description of Notations]
1, 19, 33 Substrate
2 Drop Adhesion Means
3 Drop
4 Detailed Projection
5 Continuation Film
6 Metal Mold
7 Lens Ingredient
8 Transparence Substrate
9 Light Source
10 Integrator
11 Dichroic Mirror
12 Reflective Mirror
13 Condenser Lens
14 Liquid Crystal Display Panel
15 Projector Lens
16 TFT Substrate
17 Liquid Crystal Layer
18 Micro-Lens Array Substrate
20 Ink Jet Head
21 Ink Jet Head Driving Gear
22 Ink Jet Head Control Unit
23 CCD
24 Monitor
25 X-Y Stage (with Hot Plate)
26 X-Y Stage Driving Gear
27 X-Y Stage Control Unit

28 Computer for Control
29 Black Light
30 Substrate with Taper-like Curve
31 Ultraviolet-Rays Hardening Resin
32 37 Electroless deposition layer
34 Ultraviolet-Rays Hardening Resin A
35 Ultraviolet-Rays Hardening Resin B
36 3rd Detailed Projection

[Translation done.]